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PRECISION TEST EQUIPMENT

MANUFACTURING

RESEARCH

Rutherford

ELECTRONICS CO.

PRELIMINARY

INSTRUCTION MANUAL

MODEL B-3 PULSE GENERATOR

3707 S. ROBERTSON BLVD., CULVER CITY, CALIF.

This is a preliminary instruction manual and will be replaced as soon as the corrected manual is available. To be sure of receiving your copy, please fill out and return the attached reply card.

PRELIMINARY

INSTRUCTION MANUAL

MODEL B-3 PULSE GENERATOR

SER. No. 111

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GENERAL DESCRIPTION

This 1 megacycle pulse generator is composed of four sub-assemblies with the appropriate dust cover, interconnecting wiring and air filter and fan assembly. The four units comprising this System are the Oscillator and Synchronizing Unit, the Delay and Pulse Width Unit, Power Supply for the above units and a Pulse Forming Unit.

The Power Supply is a modified version of our Model 1002 Unit. It has been modified to provide a bias of -8V at currents up to 25 milliamperes. Other than that it is a standard negative feed-back regulated supply.

The Oscillator and Synchronizing Unit generates trigger pulses continuously variable from 10 pulses per second to one million pulses per second. It also contains the necessary circuitry for external triggering of the instrument.

The Delay and Pulse Width Chassis consists of two identical delay circuits providing pulse positioning in the case of the first, and pulse width adjustment in the case of the second.

Our Model 300 Pulse Forming Chassis completes the System. This is a standard unit adapted to this application.

SYSTEM SPECIFICATIONS

FREQUENCY RANGE — 10 cycles to 1 mc in five ranges
Or external trigger from 2 volts sine wave
Or pulse up to one megacycle
Single pulse control

DELAY RANGE — 0 to 10,000 microseconds in five ranges

MAIN PULSE — Width .08 to 10,000 microseconds
Polarity - Positive or negative
Amplitude - 20 volts into 50 ohms
Rise Time - Less than .02 us.
Overshoot - 4% maximum
Duty Factor - 25% maximum

SYNC PULSES — Amplitude - 10 volt minimum
Width - .1 us.
Rise time - .05 microseconds

[illegible]

a. [illegible]

The individual units of the system may be withdrawn by removing the screws which hold the individual front panels to the cabinet. The section immediately disengages the power and signal connector and the grounding pins at the rear. In removing the Model 300 rubber mounting unit, support should be provided at the rear during the removal process, otherwise the unit may drop into the lower units. The maintenance man is cautioned that the Model 300 is exceptionally heavy and a firm grip should be obtained on the unit before removal is attempted.

If operation is desired outside the cabinet the sections may be operated on extention cables.

b. [illegible]

The air filter must be kept clean to provide adequate cooling of the instrument. A washable filter is used. The following filter cleaning instructions are given by the filter manufacturer.

"To Clean:

(1). If grease or dirt load is light, remove filter from installation and flush dirt or grease out of filter with a stream of hot water or steam.

(2). If load is too heavy for treatment in (1) above, prepare mild soap or detergent solution in pan or sink deep enough to cover filter and hold flat. Agitate filter up and down in this solution until grease or dirt is loosened and carried off filter.

(3). Rinse filter and let dry.

B. [illegible] (continued)

(4). Air or spray filter with fresh Filter Coat, or other approved adhesive. Filter Coat is available from the local representative or [illegible], in one one pint Handi-Later with spray attachment or one gallon and five-gallon containers."

At regular intervals, any dust that should settle on the interior of the instrument should be removed by means of dry compressed air. Avoid high velocity air stream which might injure the instrument or disturb adjustments. Persistent dirt may be removed with a lint free cloth, and, if necessary, carbon tetrachloride.

Under normal conditions, the silver plated contacts of the rotary switches should not require special attention. In case they become tarnished, the contacts should be cleaned by rotating the switch several times.

C. INSPECTION

A visual inspection is desirable while the instrument is being cleaned.

Switches - Turn the rotary switches while observing the contacts to check contact centering in each index position. Improperly centered contacts may be due to the switch becoming warped or twisted. Avoid pressure on the contacts as they are easily damaged.

Capacitors and Resistors - Inspect the electrolytic capacitors for leakage of electrolyte, replacing if necessary. The wax coating of paper tubular capacitors may drip if the instrument has been overheated by operating in a restricted space or with dirty air filter. This condition usually does not indicate

SECTION X (continued)

replacement. Deposition resistors should be checked for carbon discoloration which would indicate excessive dissipation and, therefore, faulty operation. A moderate amount of discoloration is normal.

Commutator - Loose wires or tube should be tightened. This is especially important when the screw serves as an electrical connector. Corrosion of the contacts and electrical components is unlikely under normal conditions. Corrosion should be removed, if evident, and the cause corrected. If the instrument must be used in a corrosive atmosphere, it may be desirable to remove the tubes occasionally and clean the contact pins with crocus cloth. Then remove and insert the tubes several times to clean the socket contacts.

3. [illegible]

It is important that the operation, circuit theory and physical location of the components be thoroughly understood before repair of this instrument is undertaken. If the trouble location of inherently simple circuits, most defects will be found relatively easy to locate.

C A U T I O N

Be sure to check the setting and adjustment of the controls before attempting to repair, to verify that the difficulty is actual.

Tube Testing

A major cause of equipment failure has been found to be weak or failed tubes. When the trouble in the instrument has been traced to a particular section, the tubes in that section

MAINTENANCE (continued)

should be checked and weak ones replaced. A Hickock #530A Tube Checker has been found to be very suitable for testing to detect tubes with low transconductance.

TEST DATA

Power Supply - (Modified Model 1002) (Ref. Drawing 1002-E-100)

Specifications: Output Voltage - 120 @ 250 milliamperes
Minus 6V @ -25 milliampere
6.3V ACC 5 amperes

Test Data: The modified 1002 requires a 5 ampere fuse to carry the additional loading of the Model 1003 Power Supply. Except for this change and the addition of the circuitry to permit the bias, the Power Supply is a conventional negative feed-back regulated unit. The only adjustment is to adjust the 120V by the potentiometer labeled R-7 on the schematic drawing, #1002E-100. Test jacks are provided for measuring this voltage. The bias supply may appear to be illogical, however, because the current flow is from the minus voltage to the higher voltage, ground, because of the action of the grids being driven positive in the blocking oscillator, the 1234 series tube is capable of regulating this negative voltage. With this in mind, it will be seen that the bias regulator is also of the negative feed-back type consisting of an 6AV6 voltage amplifier direct coupled to the grids of the 1234 series tube.

Oscillator and Sync Unit. (Ref. Drawing 1003-E-100)

Specifications: Input Impedance from "0" to 1 megacycle
2V Pulse or sine wave above 60 cycles
Internal Frequency from 10 cycles to 1 megacycle in five decade ranges.
Output pulse- 15V .1us. wide through power connector at rear of chassis.
Synchronizing pulse- 25V .1 us. wide at front panel.

TYPE 165A (continued)

Detailed Circuit Description - For external triggers for this unit, the input signal is applied through the trigger-in jack J-1 to the cathode coupled amplifier V-1. In the case of pulse input the positive pulse is taken from the plates of either V-1 or V-1 B through switch S-10, and is applied to the Schmitt trigger circuit V-2. Single pulse operation is obtained by placing S-10 in its center 'off' position and depressing the push button S-11 once for each pulse desired. For external or single pulse operation the frequency range switch must, of course, be in the external single pulse position. The internal frequency is determined by a free running multi-vibrator V-3. The frequency range is determined by switching timing condensers C-91 through C-97 across the grids and plates in the multi-vibrator. The fine frequency range is with the use of R-95, a 15K potentiometer that adjusts the screen voltage of the grid coupled tubes V-3 and V-4. Frequency is adjusted within each of the 10 and 30-300 cycles driver adjust potentiometer, available from the front panel. The adjustment procedure is to adjust R-95 for desired repetition rate and adjust R-7 to calibrate, then continually R-95 to its other, or high frequency end, adjust R-96 to calibrate R-7 at end of the range. The output from either the difference amplifier or the multi-vibrator is fed to the grid (pin 7 of the Schmitt trigger circuit V-2. This circuit converts miscellaneous wave forms fed into it to a pulse output generated across R-30. This positive pulse is then coupled to the trigger section of the blocking oscillator tube V-5 and triggers the blocking oscillator, forming the output pulse. The output is taken off of the cathode

TEST DATA (continued)

Pin 4 of the blocking oscillator to the power connector at the rear of the chassis for use in other units of the System. The positive sync pulse is derived from a cathode follower receiving its grid signal through a limiting resistor from the grid of the blocking oscillator.

Delay and Pulse Width Unit - NOTE: The delay and pulse width circuits in this chassis are identical in all respects. The pulse width section is driven from the output of the delay section in exactly the same manner as the delay section is driven from the Oscillator and Sync Unit, therefore only a description of the delay section will be given at this time. (Ref 1004 E100)

Specifications: Input Pulse - .1 us. wide 10 V amplitude
Output Pulse- 10V .1us. sync pulse 25V .1 us. wide.
Delay continuously variable in five ranges "0" to 10,000 us.

Detailed Description - For the delay range from 0 to 1 us. the input pulse is fed directly to a variable delay line DL-2, the output of which triggers the output blocking oscillator through the trigger tube V-28. For longer delays, a single shot multivibrator is triggered from the input pulse. The output of this multivibrator is differentiated by the primary inductance of transformer T-20. The pulse generated is inverted by the action of this transformer and the positive pulse is used to trigger the output blocking oscillator. The delay range is changed by switching in different values of timing condensors C-20 through C-26. The intermediate values of delay are determined by the setting of R-20, 5 megacycle potentiometer.

Delay calibration is accomplished by adjusting R-22 and R-24 both screwdriver adjust potentiometers from the front panel. The

TEST DATA (continued)

calibration procedure is to set R-26 for the long delay and adjust R-24, then setting R-25 for the shortest delay and adjusting R-23. A readjustment of R-24 may then be necessary as there is a little interaction between these two adjustments. The positive pulse from either the delay line, or the secondary of the transformer from the multi-vibrator is amplified by V-2B and triggers the blocking oscillator V-3A. The output is taken from the cathode Pin 5 of the blocking oscillator, and is sent to the output through the power connector at the rear of the chassis. Also, this signal goes on to trigger the pulse width section. The sync output is derived from a cathode follower having its grid driven through a limiting resistor in the grid of the blocking oscillator.

Pulse Forming Unit (Ref 300E100, 101, 4102)

Specifications: Input Pulse - 10V with a rise time of .1us. or less.
Output Pulse- At least 20V into 50 ohms
Rise Time- 20 mus. or less
Fall Time - 25 mus. or less
(Rise an Fall time adjustable to 1 us.)
Pulse Width - Determined by spacing of start and stop pulses, 10,000 us. maximum.
Power Required: 115V, 60/80 cycle 300W.

Detailed Description - Front panel controls adjust the polarity and rise time of the main pulse, also the amplitude is controllable by 10 db. steps and with a 10 db. fill-in attenuator. In general use the polarity control would be set in the positive position, however, by switching the knob to minus, a negative pulse is obtained. The minimum rise time of the pulse is with the rise time control in the extreme clockwise position. The rise time can be degraded to about 1 us. by adjusting this control to the counter-clockwise position. Maximum amplitude is obtained with the step attenuator in the maximum clockwise position and each step in a counter-clockwise direction attenuates the power

TEST DATA (continued)

unit by 10 db. The concentrically located fill-in attenuator adjusts between these 10 db. steps.

Two adjustments are included on the rear of this unit. One of these is an adjustment for overshoot at the leading edge of the main pulse. This is a small ceramic trimmer mounted behind the back plate and is accessible through a small hole in the rear of the unit. This condenser is labeled "Overshoot Control" and is shown on the schematic drawing as C-137. The other adjustment is a control for the flatness of the top of the pulse. It is a screw driver adjustment potentiometer and should be adjusted for the flatest possible pulse under the widest possible pulse conditions. This control is labeled "Pulse Flatness Control" and is designated on the schematic as R-137.

The pulse forming unit is designed to accept a start and a stop pulse from auxiliary equipment. It generates a DC pulse current having a time duration equal to the period between the start and stop pulses. In operation, the start pulse is fed into the unit to the grid of V-10. It is amplified by this pentode amplifier which serves as isolation to prevent RF voltages generated by the unit from getting back out into the signal lines. The output from V-10 is coupled into a succeeding amplifier V-11A. The output is differentiated by inductor L-111 and diode D-111. The resulting positive spike is used to trigger blocking oscillator forming the main pulse V-13. When V-13 fires, a charge of current is sent into the pulse forming capacitor C-135, thus forming the leading edge of the main pulse.

When the stop pulse arrives at V-20, the action is exactly the same as with the start channel until the blocking oscillator

[illegible] (continued)

V-22. The output of this blocking oscillator is sent to the grid of a discharge tube V-33. This tube is returned to a negative voltage, -100, with its grids biased below cut-off. When the positive pulse is applied to these grids, this tube then draws a large surge of current discharging C-133. To prevent this discharge from going below ground potential, the clamp diode V-34 is across the condensor.

In addition to the start and stop channels there is a gate channel which establishes the potential on the pulse forming capacitor at ground just prior to the start pulse. This circuit is a multivibrator controlling a pentode discharge or clamp tube. The operation is straight forward, even though cathode followers have been included in the multivibrator circuit to speed up its operation. When the start pulse arrives at the instrument and is amplified by V-10, then the negative pulse is applied through the decoupling diode V-30 to the multivibrator setting it in the "off" position, thus applying a negative voltage to the grid of V-35. The stop pulse for the multivibrator is taken from the plate of the blocking oscillator V-22 in the stop channel and resets the multivibrator to the "on" position returning the grid of V-33 to ground and permitting this tube to draw current and maintain the charge on C-133 at "0" volts between pulses. The output pulse taken across the pulse forming capacitor is sent to the grid of the driver amplifier stage V-40, a cathode follower, the output of which is in turn sent to the grid of the 3E29 tube through a rise time shaping network. The 3E29 output stage is connected as a cathode follower for positive output pulses, and as a unity gain

[illegible] (continued)

inverting amplifier for negative pulse outputs. In this switching operation, first the cathode resistor and in the second case, the plate resistor are connected to ground so that the reference of the pulse is always at "0" volts with respect to the chassis. That is, the main pulse is direct coupled out.

Fill-in amplitude control is provided by varying the DC restoration voltage on the 6CB6 grid, thus permitting the output tube to clip or use only part of the signal into the grids. This restoration is accomplished by V-4C and R-424 with the amplitude controlled by the amplitude potentiometer R-423 controlled from the front panel. The output pulse from the cathode or plate resistor is then sent through a step attenuator consisting of five 13 Db. constant impedance T sections, the first of these having high power ratings to accomodate the high power capabilities of the pulse generator. The switches for these various sections are ganged together and controlled by one knob on the front panel.

The 300 Watt has its own self-contained power supply, since all leads into the instrument want to be by-passed to ground in order to prevent RF from getting back into the AC power line. The voltages required by the pulse forming circuits of the unit are + 300, +150, -25, -50, -100 and -150 Volts, with respect to the ground. Also, a floating supply is required for the output stage having a potential of approximately 400 V and -150V with respect to the referenced point. The power supply portion consists of a straight forward power supply having a capacitive input filter followed by electronic regulation employing negative feedback. Negative voltages are derived by the use of selenium rectifiers and voltage regulator tubes for reference. The +150V is derived from

(continued)

the -300 V by a dropping resistor as the current of this supply is constant. The -25 and -300V are derived from cathode followers V-64. This is possible in that the bias is used on grids of blocking oscillators and even though the bias is negative, during the pulse the grids draw positive current. Current therefore, is out of the supply instead of into it. The floating supply for the output stage is a capacitive input pi network employing resistance between the capacitors. This is a low impedance, high current supply. Again selenium rectifiers and gas diodes are used for deriving the negative voltage. Separate fuses are used for each of these power supplies. Fuse 1, or 601 as it is called on the schematic, provides overall protection for the instrument in case of short-circuit or other failure conditions. Fuse 2, or 701 on the schematic, fuses only the primary of the floating power supply used by the output tube. This fuse is designed to blow in the event that the ratings of the output tube should be exceeded either by excessive duty factor or by failure on the part of the circuits in the System. If Fuse 2 is noted to blow insistently, it may be well an indication of improper operation of the instrument.

CLASP THE HUBBS LINES ENVELOPE

No. 75 - 7½ x 10½

DEC 19 1956

MR. W. R. JAMES - 2310

Re: Sole Source Justification for Model B-3 Rutherford Megacycle Pulse Generator

A specific need in testing XT-529 and XIT-529 prototypes has arisen for a laboratory pulse generator with a variable repetition rate going up to at least 1 megacycle and provision for low impedance output pulses coincident with the leading and trailing edges of the main pulse.

A second application, testing XT-311 and XT-312 prototypes, requires a similar generator having the following additional characteristics:

Rise Time:	less than .02 microseconds
Fall Time:	less than .025 microseconds
Pulse Width:	adjustable .08 to 10,000 microseconds
Polarity:	+ or -
Amplitude:	20V into 50 ohm load at 25% duty factor at maximum repetition rate.
Overshoot & Undershoot:	4% maximum (when terminated with 50 ohm load)

A search for generators currently on the market revealed only one unit meeting both the above requirements:

Rutherford Electronics Company - Model B-3

The available catalog literature of the following firms was checked:

Hewlett Packard
Berkeley Division, Beckman Instruments, Inc.
Burrough's Electronic Instrument Division
General Radio Corporation
Lavoie Laboratories, Inc.
Electro Pulse, Inc.

Original Signed by
E. L. DEETER

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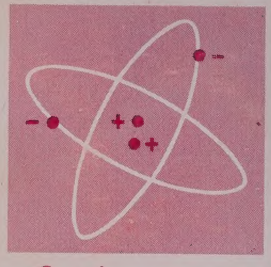

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